K Poggeshall (H) 8504.aa

A TREATISE OF MEASURES,

BY A

Two-Foot Rule, which Slides to a Foot:

On which is,

The best Measure of ROUND TIMBER the common way.

ALSO

The true Measure of Round, Square, or other Regular *Timber*, or *Stone*, *Board*, *Glass*, *Paving*, *Painting*, *Wainscot*, &c. Gaging of Vessels, whether ordinary Cask, or Great Tuns.

WITH A

Diagonal Scale of 100 Parts in a quarter of an Inch, easie to make and use.

By *H. C.* Gent.

London, Printed by *A.G.* and *J.P.* and are to be Sold by *Henry Wynn* Mathematical Instrument-Maker, next the *Sugar Loaf* in *Chancery-Lane*. 1682.

8504. aa. 45

John Rabett

1682

Johannes Rabett
Clarmaker

Reginald: Rabett
his Booke
1714

How to measure timbr by ye slip rule.

Sett ye :: pricks to ye length of ye tree, & if ye girt be above 12 inches you must look on ye right hand part of ye rule & if undr 12 you must look on ye left part & just above ye girt there is how many foot of timbr is contain'd in that peice. The same way you may measure Plank or board.

Note that ye side of ye rule wch have W.A is timbr measure

BRITISH MUSEUM

TO THE READER.

THIS Rule having the Approbation of Perſons of ſeveral conditions and callings, who have occaſion for the Meaſures performed hereon; I have reviſed the Book ſet forth therewith. Which being very ſhort, and falſe Printed, (ſome faults alſo having eſcap't me in the Examples) was no great advantage to the Rule. I have altered it; abundantly, I hope, for the better; as you will find upon peruſal of the Contents; and given it a Title more ſuiting the ſerviceableneſs of the Rule. I have alſo much improved the Rule, by adding ſome Subdiviſions to the Square-line, and the Line of Numbers his fellow, for the better reſolving ſome

Queſtions, which are very uſeful; by which alſo the Timber meaſure hereon, being comprized in two Caſes, is performed by one general Rule. As for the Scale, it is as certain as any, and of as eaſie uſe; but far more eaſily made, and ſo cheaper than that of *J. W.* To the deſcription whereof, as an Appendix, I have added the way of reducing the Fraction-ſinks of *Gunters* Chain into Poles, or Perches: Which I find in Mr. *Wingates* Arithmetick: Alſo the Reaſon thereof is intimated, which he there reſerves. I have reſolved ſome Queſtions by the Logarithms, to ſhew the great eaſe and certainty of working by them: The Compendiouſneſs whereof the Rule every where imitates. One thing more I ſhall add, that he that uſeth this Rule chiefly for Gaging, may have the Square-line ſubdivided decimally onely, as it will bear: Which he will find more convenient for his purpoſe.

Henry Coggeshall.

THE CONTENTS.

THE *several Lines on the Rule.*

Sect. 1. *A clear explanation of the Line of Numbers.*

2. *The like of the Square-line, and some points thereon.*

3. *The general use of double Scales.*

PART I.

PROP. 1. *The measure of round Timber the common way, viz. by the length in Feet and the Girt (a quarter of the Circumference) in Inches. Fractions explained.*

2. *True measure of round Timber, or Stone by the same: Also of Stone by the Diameter.*

3. *Square Solids.*

4. *To find a mean Proportional between two Numbers, in order to what follows.*

5. *Unequal Squared Solids.*

6. *Solids of a Triangular Base.*

7. *Solids,*

7. *Solids, whose Bases are Regular Figures.*

8. *Another way of measuring these Solids by Foot-measure onely.*

9. *Having the Girt; to find the side of the Square equal, near.*

10. *Having the Girt; to find the side of the Square within near; The usefulness of this Proposition, and a reason of the continuance of the common way.*

11. *To find how many Inches in length make a Foot Solid, at any Girt or Square not exceeding 40 Inches.*

12. *Exact measure of a Solid, that tapereth strait.*

13. *To set the Square-line to his Squares, and thereby to Square a Number not exceeding 100: And to find the Square-root of a Number not above 10,000.*

14. *Having the Diameter of a Circle; To find the Area, or Superficial Content: With a direction, when the third Number on the Square-line is beyond the Line of Numbers.*

15. *Having the Circumference of a Circle; to find the Superficial Content.*

16. *To enlarge or diminish a Square, Circle, or other Regular Figure at a Rate given, which holds in any other Figure; so it be made alike, and like situated to the given.*

17. *Addition, Subtraction, Multiplication, and Division in Decimals.*

18. *Gaging of ordinary Vessels according to Mr.* Wingate, *also by the Logarithms, with his Answer to an Objection.*

An Appendix, concerning the nature and some uses of the Logarithms.

19. *To Gage a stand. Also by the Logarithms.*

20. *Gaging great Tuns,* viz. *Square, Long-square, Cylindrical, and Conical; and by the Logarithms.*

21. *The measure of a Shell, or Flitch of Timber.*

22. *To enlarge or diminish a Ship (or other Solid,) keeping the Mould.*

PART II.

THE use of the double Scale in some Superficial measures.

Some Premises.

Prop. 1. *Multiplication.* Sect. 1. *The Square.* 2 *The Long-square, in three Questions.* 3 *The Triangle.* 4 *Trapezia of several sorts.* 5 *Any Regular Figure.* 6 *The Circle, and his Parts. The proportion of Circumference, and Diameter.* 7 *To reduce the aforesaid Figures to Squares.*

2. *Division in four Questions.*

3. *The Rule of Three, in the measure of* (Sect. 1.) *Plank or Board, and Glass.* 2 *Where length and breath are taken in Inches.* 3 *By the Yard.* 4 *By the Square.* 5 *By the Rod.* 6 *By the Acre. Directions to put on some useful Points.*

4. *The Inverse Rule.*

5. *Fractions:* Sect. 1. *Of* 2 *shillings.* 2 *Of a Yard.* 3 *Of a Square.* 4 *Of a Rod.* 5 *Of an Acre.* 6 *Fractions not Decimal.* 7 *Fractions into Decimals. An advice concerning the length of the Lines.*

PART III.

1. THE Scale.

2. *The Use.*

3. *To reduce the Fraction-links of* Gunters *Chain into Poles.*

4. *A*

The Contents.

4. *A ready and exact way by the Rule.*

Prop. 1. *Timber measure by the Logarithms.*

2. *To find the Content of a Tree growing, not disbarking it.*

3. *To find the Diameter of the head of a Vessel within near.*

4. *Reduction of Wine-measure to Ale-measure, and contrary.*

THE

A TREATISE OF MEASURES.

The Preface.

THERE are four Lines on each flat of this Rule; two next the outward edges, which are Lines of Measure; and two next the inward edges, which are Lines of Proportion.

On one flat, next the inward edges, is the Square-line with the Line of Numbers his fellow. Next the outward, a Line of Inches divided into Halfs, Quarters, and Half-quarters; from 1 to 12 on one Rule; and from 12 to 24 on the other.

On the other flat, next the inward edges, is the double Scale of Numbers. Next the outward, on one Rule a Line of Inches divided each into ten parts; and this for Gauging, *&c.* On the other a foot divided into 100 parts. And this I mean, when I mention Foot-measure. The beginnings of both these Lines are at the ends of the Rules; the ends at the broad loup, or middle, when the Rule is set to two Foot.

Sect. 1. *The Line of Numbers,*

COmmonly called *Gunters* Line, (whereof there are 3 on this Rule, *viz.* Two, which makes the double Scale; and one, against which the Square-line slides,) is in two lengths. That is, from 1 at the beginning to 1 in the middle, which is the first length; and from 1 in the middle to 10 at the end, which is the second length.

The proper Numeration of it I account, 1 at the beginning, and so by 10 in the middle, to 100 at the end.

But for the better understanding this Line; see here the degrees of Number from *Unit* on either side, as they stand on the Line; that is encreasing from left hand to right.

Thou.pts.	*Hun.pts.*	*Ten.pts.*	*Unit.*	*Tens.*	*Hund.*	*Thous.*
.001	.01	.1	1	10	100	1000

Where

Where you ſee, how they increaſe on one ſide from *Unit*, and on the other ſide decreaſe from the ſame, in a Ten-fold proportion. So that if you place any one of them at the beginning of the Line; the two next following ſhall be; one the middle, the other the end. As if you call 1 at the beginning one Tenth; the middle ſhall be 1, and the end 10. If you call 1 at the beginning 10; the middle ſhall be 100, and the end 1000. But if it be not otherwiſe limited, account it, as I ſaid before, 1, 10, 100.

The Subdiviſions of thoſe, which are the double Scale, are thus: From 1 to 10 (or the whole firſt length) into Ten parts; from 10 to 20, into Five parts; from 20 to 50, into Two parts; from thence to the end not ſubdivided at all.

The Rules made by Mr. *Wynn*, are more nicely Subdivided. Some of them thus: From 1 to 2, in either length, in every Line, each tenth into Ten: From 2 to 3, each into 5; from thence, in ſome Rules to 6; in ſome to 7; in ſome to the end; each tenth into two.

But for the better working ſome Propoſitions following, and reducing the *Timber-meaſure* hereon to one general rule: I would have the firſt length of that againſt which the Square-line ſlides, ſubdivided in every reſpect as the ſecond.

Sect. 2. *The Square-line,*

CAlled alſo (where the meaſure of round Timber is concerned) the *Girt-line*, is one whole length of the Line of Numbers; but at a double Radius: It being exactly equal to the Lines of Numbers on this Rule, which are in two lengths.

On the firſt made Rules it began at 4, and was unequally divided to 40. Each diviſion ſubdivided into 4, it repreſenting chiefly Inches with their Halfs and Quarters. Numbred thus, 4, 5, 6, 7, 8, 9, 10, 20, 30, 40.

But for the reaſons above mentioned, I would have it,

Firſt, Divided from 4 to 10, each into Ten parts; every Tenth ſubdivided into 2; and cut or diſtinguiſhed, as that part of the ſecond length of the Line of Numbers, from 2 to 5. So the Halfs and Quarters, are ſtill clear; By this, one whole length, though broken, is divided by decimal partition; and ſubdivided from 1 to 4, into Four parts, and from 4 to 10, into 2. I ſay from 1 to 4; for, when occaſion requires, you muſt account 10, 20, 30, to be 1, 2, 3. As alſo 4, 5, 6, 7, *&c.* to be 40, 50, 60, 70, *&c.*

2. Let

Secondly, Let the Diviſions 38 and 39, with their Halfs and Quarters, be put on before 4 at the beginning of the Line; and cut as in their proper places.

At 12 on this Line let there be 4 pricks in a *Rhombus*, thus ⁘ At 17.15 the Wine-point, Marked *W*. At 18.95 the Ale-point, Marked *A*. Theſe are put on by the Work-man.

At 10.635 may be a point, like the Gauge-points, for finding the true content of a round Solid by the Girt.

At 41.57 ſuch another, to ſhew how many Inches in length make a Foot Solid, at any Girt or Square not exceeding 40 Inches.

Theſe, being not very neceſſary, your ſelf may put on thus: For the former; ſet 12 on the Square Line to 14 on the Line of Numbers; againſt 11 on the Line of Numbers, Mark this point. The latter thus: Set 12 on the Square Line to 1 at the beginning of the Line of Numbers; againſt 12 on the Line of Numbers, Mark this point.

Theſe, or any other mentioned hereafter, cut with a ſharp pointed Pen-knife, in two places, as the Gauge-points: and ſtrike in with your finger, ſome ſallow Coal fine ground with Linſed Oyl; and then wipe the Rule clean.

Both these Lines are put on from the Logarithms: I will next shew,

Sect. 3. *The general Use of Double Scales.*

IT is chiefly for the Working the Rule of Three, or having Three Numbers given; to find a fourth proportional. It including Multiplication and Division, for there is no other difference; than that in these two an Unit is one of the three.

To find this Fourth: Set the first Number on the first Rule, to the second Number on the second Rule; against the third Number on the first Rule is the fourth on the second Rule. For Example: If 2 give 3; what shall 6 give? Set 2 on the first to 3 on the second; against 6 on the first is 9 on the second. Wherefore, where I say: Set 2 to 3; against 6 is 9: I mean, as in the above set Example; though I name not the first or second Rule: Yet you may note; that the moveable or longer Rule is for the most part the first; whether side soever of the two you work on.

PART I.

PROP. I.

To Meaſure round Timber the common way.

MEaſure the length in Feet, and half Feet; and (if the cuſtom or agreement be ſo) in Quarters; which reſerve. Then back again half way, where girt the Tree with a ſmall Cord or Chalk-line: Double this line twice very even; this fourth part of the Circuit (which in this Treatiſe I call the Girt) Meaſure in Inches, Halfs, and Quarters of Inches: And this obſerve, that the lengths be given in Feet: The Girts and ſides of Squares in Inches.

So have you three Numbers given, *viz.* 12 always the firſt, the length always the ſecond, and the Girt or ſide of the Square the third.

To come now to the Rule: Set 12 on the Girt-line to the length on the Line of Numbers; againſt the Girt on the Girt-line is the content on the Line of Numbers. And this is the general Rule.

Now

Now there being two Caſes: one, when at the firſt ſet, the Girt is againſt ſome part of the Line of Numbers: The other, when it is not; So that 12 muſt be removed: I will give you ſeveral Examples of both.

But to make all clear, firſt underſtand theſe Fractions, $\frac{1}{4}$ one quarter, $\frac{1}{2}$ one half, $\frac{3}{4}$ three quarters. Other Fractions ſpoke to in this Book are Decimals; they are wrought as whole Numbers; and have always a prick before them.

There value is known by the Number of places in the Decimal: As if there be but one Figure; it is tenth parts: If two, they are hundred parts: If three, then thouſand parts; *&c.* Theſe Fractions are always ſet before the name of the whole; whether it be Inch, Foot, Yard, *&c.* a few Examples will make all eaſie.

Read therefore theſe thus: 35 $\frac{1}{2}$ F. thirty five Feet and an half, 14 $\frac{1}{4}$ In. fourteen Inches and a quarter, 8 $\frac{3}{4}$ In. eight Inches and three quarters, 2.7 F. two Feet and ſeven tenths, 17.64 Y. ſeventeen Yards and 64 centeſms or hundred parts, 3.47 Rod. three Rods 47 cents, 3.05 F. three Feet and 5 cents, *&c.* A further account of theſe Decimals you ſhall have after.

CASE I.

Case I.

Ex. 1. A Tree is 35 ½ F. long, 14 ¼ In. Girt. Set 12 on the Girt-line to 35 ½; againſt 14 ¼ is 50 F. the content.

2. The length is 8 ½ F. the Girt 35 ¾ In. ſet 12 to 8 ½; againſt 35 ¾ is 75 F. and almoſt an half.

3. The length is 15 F. the Girt 42 ½ In. ſet 12 to 15; againſt 42 ½ is 188 F.

4. A Rail is 15 F. long; the Girt 3 Inches: ſet 12 to 15; againſt 3 is 9 tenths of a Foot and more *viz.* 94 cents.

5. A Wrong is 10 F. long, the Girt 5 In. ſet 12 to 10; againſt 5 is 1 F. and three quarters almoſt, *viz.* 1.73 F.

6. The length is 20 F. the Girt 57 ½ In. ſet 12 to 20; againſt 57 ½ is 459 F.

7. A length is 9 ½ F. the Girt 39 ¾ In. ſet 12 to 9 ½; againſt 39 ¾ at the beginning of the Girt-line is 104 F.

8. A length is 0.62 F. the Girt is 35 In. ſet 12 to the Decimal .62 in the firſt length; againſt 35 is 5 ¼ F. which may ſerve for a ſhort cut of a Tree.

If

If this length had been propounded 7 $\frac{1}{2}$ In. It muſt have been turned into Foot Meaſure thus: On the double Scale; ſet 12 to 100; againſt the length in Inches is the length in Foot meaſure. But if it lies before you; meaſure it by the Line of Foot meaſure on the Rule.

CASE II.

IF, at the firſt ſet, the Girt is beyond the Line of Numbers, remove 12 to the length in the other length thereof.

Examp. 1. The length is 18 F. the Girt 31 In. ſet 12 to 18 in the firſt length; againſt 31 is 120 F.

2. A Rail is 15 F. long, and 3 $\frac{1}{2}$ In. Girt: ſet 12 to 15 in the firſt length; againſt 3 $\frac{1}{2}$ is 1 $\frac{1}{4}$ F. and a little more, *viz.* 1.27 F.

3. A Wrong is 6 $\frac{1}{2}$ F. long, the Girt 4 $\frac{1}{4}$: ſet 12 to 6 $\frac{1}{2}$ in the ſecond length; againſt 4 $\frac{1}{4}$ is above eight tenths of a Foot: Theſe Examples I hold ſufficient.

Note, 1. If you would find the content of a piece of Timber immediately in Loads, at 40 F. to the Load; uſe half the Girt inſtead of the whole. *Ex.* A length is 15 F. the Girt 42 $\frac{1}{2}$ In. ſet 12 to 15; againſt 21 $\frac{1}{4}$ is 47: Whereof the 4 is 4 Loads, and the 7 is 28 F.

By

By this way (if your Rule be not ſubdivided as above) you meaſure Timber, whoſe Girt is above 40 In. as alſo the piece in the ſeventh Example: Which, without the ſaid ſubdiviſions, and placing 38 and 39 before 4 at the beginning, are under neither caſe.

But if you would have the content of theſe pieces in Feet; Multiply the content found by 4, the Square of 2, by which you divided your Girt: So 47 Multiplyed by 4 is 188 F.

2. To what length ſoever you ſet 12; 17 will ſtand to the double thereof, $8\frac{1}{2}$ to half thereof, both a little over. Alſo 24 will ſtand to the quadruple thereof, and 6 to a quarter thereof exactly; and the ſame proportion the content bears to the length at any of theſe Girts, *viz.* at 17 In. Girt, the content is double the length; at $8\frac{1}{2}$ In. Girt, the content is but half the length, *&c.*

PROP. II.

True meaſure of round Timber, or Stone by the Girt; alſo of round Stone by the Diameter.

BEcauſe this common way of meaſuring round Timber giveth not a true content, but always too little (though it be ſtill generally

rally uſed, and will be, whereof you have a reaſon hereafter): I have given you a point, and ſhewn, how you may put it on your Rule: which ſetting to the length inſtead of 12, the Girt ſhall point you out a true content; accounting it a Cylinder, as the ſaid common way alſo doth.

Ex. Let the length be 10 F. the Girt 15 In. ſet the ſaid point to 10; againſt 15 you have 20 F. lacking about one tenth: whereas the common way giveth but 15 F. and a little above an half.

Alſo this way a Cylinder of Stone, whether long as a Column, or ſhort as a Milſtone (the thickneſs of this latter being the length, which muſt be meaſured in Foot-meaſure,) may be meaſured to a true content. Such an one you may account the piece in the Eighth Example. But the Diameters of theſe being eaſily meaſured: If you ſet 13.54, (where a point may be made, if you have much uſe of it) to the length in Feet; the Diameter in Inches giveth you a true content.

Thus far by the Length and Girt: which to meaſure when it is above 12 Inches; the narrow loup may be opened: So hanging the double nooſe thereon; the ſingle nooſe may be extended among the Inches beyond 12, to the due extent, or length.

I ſhall only add; that the common meaſure is to the true, as 11 to 14. So that ſetting 11, on the double Scale, to any number of Feet, or Loads meaſured the common way; 14 ſhall give you the true content of the ſame. And ſetting 14 to the true content; 11 ſhall give you the content the common way.

PROP. III.

Square Solids.

SEt 12 to the length in Feet; againſt the ſide of the Square in Inches is the true content. The caſes are as in round Timber: the Examples alſo will ſerve, accounting the Girts to be ſides of Squares.

PROP. IV.

To find a mean Proportional between two Numbers.

SEt the greater of the two Numbers on the Square-line, to it ſelf on the Line of Numbers; againſt the leſs on the Line of Numbers, is the mean Proportional on the Square-line.

Or ſet the leſs on the Square-line to it ſelf on the Line of Numbers; againſt the greater on the Line of Numbers, is the mean on the Square-line. One of theſe will not fail. Examples follow in the next.

PROP. V.

Unequal Squared Solids.

HAving meaſured the length in Feet: Meaſure the breadth and depth in Inches. Then find a mean between the breadth and depth, as is next above taught: It ſhall be the ſide of a Square equal to the baſe or end; which had, Meaſure as Square Timber.

1. *Ex.* in Timber, whoſe length let be 10 F. the breadth 21 In. the depth $8\frac{1}{2}$ In. Set 21 to 21; againſt $8\frac{1}{2}$ on the Line of Numbers is 13.36: or 13 a Quarter and Half-quarter near. Or ſet $8\frac{1}{2}$ to $8\frac{1}{2}$; againſt 21 on the Line of Numbers is the ſaid 13.36. Then ſetting 12 to 10; againſt 13.36 is 12.4 F.

2. *Ex.* In Stone, which let be 6.35 F. long, $36\frac{1}{2}$ In. broad, 5.7 In. deep. Setting $36\frac{1}{2}$ to it ſelf; againſt 5.7 on the Line of Numbers is 14, and ſomething ſhort of an half. Then ſet 12 to 6.35; againſt this mean is 9.2 F. near.

This

This mean, in caſe of a Fraction, ſhall give you no trouble: For, if with a Pencil, Chalk, or any thing, that may be wiped out without damage to your Rule (let it not be Ink) you make a fine Mark on the Square-line at this mean, and then ſet 12 to the length; this Mark, without defining it, ſhall point out your content.

PROP. VI.

Solids of a Triangular Baſe.

FInd a mean Proportional between the Baſe and half the Perpendicular, or between the Perpendicular and half the Baſe, both meaſured in Inches. This mean is the ſide of a Square equal to the Triangle. Then ſet 12 to the length in Feet; againſt this ſide is the content.

If two ſides of the Triangle be equal; the unequal ſide may be the Baſe. If the three ſides be unequal; the longeſt ſide is commonly the Baſe. From whence the neareſt diſtance to the oppoſite Angle is the Perpendicular.

PROP. VII.

Solids, whoſe Baſes have many equal ſides, and equal Angles.

THeſe Baſes are regular Figures: Having the length in Feet; meaſure the Circuit in Inches. Get alſo the Perpendicular from the Center to one of the ſides in Inches: So ſhall the mean between the Perpendicular, and half the Circuit, be the ſide of the Square equal to the Baſe: which had; meaſure as Square Timber.

Ex. A piece of Timber 8 Square, as we may call it, is 10 F. long; each ſide 12 Inches. The Perpendicular 14.48 Inches, which you may call $14\frac{1}{2}$. Set $14\frac{1}{2}$ to $14\frac{1}{2}$; againſt 48 half the Circuit (being 96) is 26.4 on the Square-line, or there make a Mark. Then ſet 12 to 10; againſt this Mark is 48 F. and little more than a quarter.

And thus much of theſe ways of Timber meaſure, which, being the main occaſion of the Rule, and not depending on any thing which followeth, I have ſet in the firſt place.

PROP.

PROP. VIII.

Another way of meaſuring theſe Solids; by Foot meaſure only.

GEt the Area or ſuperficial Content of the Baſe in Feet: if it be round, by either *Prop.* 14 or 15; if of any other Figure before ſpoken of, by *Prop.* 1. *Part* 2. following. Which multiplied into the length in Feet, the Product is the Content. The two next *Prop.* are wrought on the double Scale.

PROP. IX.

Having the Girt; to find the ſide of the Square equal near.

AS 7 to 7.9; So the Girt to the ſide of the Square equal. Let the Girt be 15 In. Set 7 to 7.9; againſt 15 is 16.9 near; this ſide, having ſet 12 to the length in Feet, gives a true Cylindrical Content.

PROP. X.

Having the Girt; to find the ſide of the Square within.

AS 10 to 9; So the Girt to the ſide of the Square within. Set 10 to 9; and againſt 15, for Example, is 13 $\frac{1}{2}$. And ſo much will ſuch a piece bear Square.

By which you may know, before a piece be hewn, how many whole Board or Plank, of any thickneſs, may be had out of it.

From hence alſo you may ſee, That the Girt, though leſs than the ſide of the Square equal; yet is greater than the ſide of the Square within: toward which moſt Timber muſt be hewn, before it can ſerve to any Square uſes; which may be the reaſon of the continuance of the ſaid common way. And of this mind is Mr. *Henry Philips* alſo in a Treatiſe of his.

PROP.

PROP. XI.

To find how many Inches in length make a Foot Solid, at any Girt or Square, not exceeding 40 *Inches.*

SEt the ſaid Girt or Square on the Square Line, to 1 at the beginning of the Line of Numbers; againſt 41.57 are the Inches, which make a Foot.

So ſetting 6 to 1; againſt 41.57 is 48; and ſo many Inches in length make a Foot at 6 In. Girt or Square.

And now having done with the meaſure of ordinary Timber, let me advertiſe any Reader, that hath not ſeen much meaſured; That if a Tree fall ſuddenly away; as, admit upon cutting one arm off, where it divided into two, or for any other cauſe; it is neceſſary to Girt ſuch a Tree twice; yea thrice if there be cauſe: otherwiſe there will be loſs to buyer or ſeller.

Alſo they ſay, the buyer hath priviledge to Girt any where, between the middle and the ground end, if it be for his advantage.

PROP. XII.

Exact measure of a Solid, that tapereth strait.

THe Rule I find in Mr. *Wingate* (it seems from Mr. *Oughtred*) thus: Having multiplied the greater Base by the less; of that product extract the Square Root. Then if by the aggregate of both Bases and the Square Root you multiply the third part of the length of the Solid propounded; this product is the Solid content required.

To apply this Rule: If the Solid be round you will find the superficial Contents or Bases by *Prop.* 14. following: If it be any other regular Figure, (and such only are here intended) you will find the Bases by *Prop.* 1. *Part* 2. following.

This premised: Let the length of a round Solid be 10 F. The greater Diameter 2.47 F. Hence, by *Prop.* 14. his Base will be found 4.79 F. The less Diameter 2 F. his Base by the same 3.14. F.

Instead of multiplying and extracting the Square Root; set 3.14 on the Square-line to it self on the Line of Numbers; against 4.79 on the Line of Numbers, is 3.88 the Square Root.

The

The aggregate of both Baſes and this Square Root, or Mean, is 11.81. Inſtead of Multiplying this into a third part of the length; on the double Scale: Set 3 to either length or aggregate; againſt the other is the content. So here ſet 3 to 10; againſt 11.81 is 39.37 F. the Content required. *Addition*, *Subtraction*, *Multiplication*, and *Diviſion*, in *Decimals*, will be ſhewn, *Prop.* 17.

PROP. XIII.

To ſet the Square-line to his Squares; and thereby to Square a number not exceeding 100. *To find the Square Root of a number not exceeding* 10,000.

1. SEt 10 on the Square-line to 1 at the beginning of the Line of Numbers, both which if you account 1; you have on the Line of Numbers the Squares from 1 to 16. Alſo at this ſet it is moſt convenient to take the Squares from 1000 to 1600; *viz.* by accounting 10 on the Square-line 10, and 1 in the middle 1000.

2. Set 10 on the Square-line to 1 in the middle, accounting 10 on the Square line 10, and 1 in the middle 100: you have the Squares on

on the Line of Numbers from 16 to 1000; and of this you will make moſt uſe.

3. Set 10 on the Square-line to 10 at the end; accounting 10 on the Square-line 100, and 10 at the end 10,000. So have you on the Line of Numbers the Squares from 1600 to 10,000: and againſt all theſe Squares at every ſet, his own Root.

Ex. I would put 380 Men into the neareſt Square they will bear. I ſet 10 on the Square-line to 1 in the middle, accounting it 100; 380 on the Line of Numbers, falls between 19 and 20 on the Square-line; againſt 19 is 361 for his Square againſt 20, 400 for his.

PROP. XIV.

Having the Diameter of a Circle; to find the Area, or ſuperficial Content.

SEt 1 on the Square-line to 7.854, (which would be cut as the Gage-points, it being a very uſeful point;) againſt the Diameter on the Square-line is the Superficial content.

Ex. Let the Diameter be 1.7 F. ſet 1 as above to 7.854; againſt 1.7 is 2.27 F. near: whence it is as eaſie, having the Superficial content, to find the Diameter, or to caſt any Num-

Number into a Circle. So are the Gage-points put on; they being the Diameters of Circles, whoſe Area's are equal to the Number of Cubical Inches in the Gallon of Wine, or Ale reſpectively. So the Rule being ſet as above; againſt 231 is the Wine-point; againſt 282 the Ale-point.

Note, that whereas ☞ in uſing the Square-line, ſome part of it may be beyond the Line of Numbers, mark the following Rule. Obſerve well what Diviſion on the Square line happens exactly, or very near to ſome Diviſion, on that length of the Line of Numbers beyond which the ſaid third Number ſtands. To this Diviſion in the other length remove the ſaid Diviſion on the Square-line; ſo ſhall the ſaid third Number be brought againſt his due place.

So in this Example, the Square-line goeth off at 35.7; but you will ſee 24 ½ on the Square-line to ſtand to 47 on the Line of Numbers; to 47 therefore in the firſt length remove 24 ½ on the Square-line; and it goeth on then to the end.

PROP.

PROP. XV.

Having the Circumference of a Circle; to find the ſuperficial Content.

SEt 1 on the Square-line to 7.96; againſt the circumference is the Superficial content. So the circumference being 8 F. if you ſet 1 on the Square-line to 7.96; againſt 8 is 5.093 F.

PROP. XVI.

To enlarge, or diminiſh a Square, Circle, or other regular Figure, at a rate given.

1. TO enlarge it: Set the leſs term of the rate given, on the Line of Numbers to the ſide or Diameter given on the Square line; againſt the greater term on the Line of Numbers is the ſide or Diameter required.

Ex. If a 1000 Men lodge in a Square, whoſe ſide is 60 paces; how many paces ſhall the ſide of a Square be, wherein 5000 Men may ſo lodge? Set 1000 in the middle of the Line of Numbers, to 60 on the Square-line; againſt 5000 on the Line of Numbers is about 134, and ſo many paces muſt the ſide be.

2. To

2. To diminiſh it: Set the greater term ſo; and againſt the leſs on the Line of Numbers is the ſide or Diameter required.

Ex. I would diminiſh a Circle, whoſe Diameter is 10 F. at the rate of 8 to 5: Set 8 on the Line of Numbers, to 10 on the Square-line; againſt 5 on the Line of Numbers is 7.9 for the Diameter required.

PROP. XVII.

Addition, Subtraction, Multiplication and Diviſion in Decimals.

FOr the ſurer working ſome Propoſitions following, I will as briefly as I can, ſhew you to Add, Subtract, Multiply, and Divide in Decimals, and mixt Numbers.

A *Decimal* is the Numerator of a Fraction, whoſe Denominator is a *Unit* with Cyphers, which Denominator is never expreſſed; becauſe it hath always ſo many Cyphers annexed to the *Unit*, as there are places in the Numerator or Decimal.

As for Example, this .2 is 2 tenths, or, $\frac{2}{10}$: this .02 is 2 hundred parts, expreſſed thus, $\frac{2}{100}$, *&c.* So $\frac{1}{4}$ changed into a Decimal is .25: $\frac{1}{2}$, .5: $\frac{3}{4}$, .75: *viz.* 25 cents, 5 tenths, and 75 cents.

The work is the ſame, as in whole Numbers, with theſe directions. In *Addition*, and *Subtraction*, the pricks prefixt to the Decimals muſt be ſet under one another, by which means the *Units* in the whole Numbers ſtand alſo under one another.

Alſo in *Subtraction*, although a Cypher at the right hand of a Decimal is of no value (as theſe .3, .30, .300, are no more than 3 tenths,) yet, if the Decimals conſiſt not of an equal Number of places; you muſt annex Cyphers, or ſuppoſe them annexed.

EXAMPLES.

Addition.

22.75	19.2	.17
9.6	4.68	.89
32.35	23.88	1.06

Subtraction.

22.75	19.2	107.
9.6	4.68	8.93
13.15	14.52	98.07

But in Multiplication: Set them, as if they were whole Numbers, and ſo Multiply them; Cutting off from the laſt product ſo many Figures

gures to the right hand, as there are places in the Decimals, both of the Multiplicand and Multiplier; ſo the reſidue is the whole part of the product, and the Figures cut off the Decimal.

If the Product hath not ſo many places, as there are places of Decimal parts in both Numbers; ſupply the deficient places with Cyphers prefixt to the left hand thereof.

EXAMPLE.

46.25	.87	564
35	.9	.5
23125	.783	282.0
13875		
1618.75		

.0375	.76	22
.05	8	.07
.001875	6.08	1.54

By theſe Examples, it is eaſie to know, how to diſtinguiſh the Whole part of the Product from the Decimal part.

In *Diviſion*, it is ſomething harder to diſtinguiſh the Whole part of the Quotient from the Decimal part thereof.

The Rule I find in Mr. *Wingates* Arithmetick ſet out by Mr. *Kerſey*; which well underſtood, will carry you through in any of the caſes.

Having ſet the Diviſor under the Dividend, as if they were whole Numbers (which Dividend muſt ſometimes have Cyphers annexed, that the Diviſion may be continued as far as is ſufficient;) Obſerve well what place or degree of the Dividend ſtandeth over the place of *Units* in the Diviſor of the queſtion; whether theſe places be real, or only ſuppoſed; of the ſame degree or place is the firſt Figure of the Quotient. The degrees you have had before, as anſwering the Line of Numbers: See them now in their natural order; which may be continued either way from *Unit*.

Thouſ.	*Hund.*	*Ten.*	*Unit.*	*Ten.pts.*	*Hun.pts.*	*Thou.pts.*
1000	100	10	1.	.1	.01	.001

I have here ſet ſome Examples, with the two firſt Figures in the Quotient.

Dividend 180.0000 (30. *&c.*
Diviſor 5.875

Di-

Dividend 1.75000 (.02 *&c.*
Diviſor 63

Dividend .74600 (31. *&c.*
Diviſor .024

Dividend 9.720 (.23. *&c.*
Diviſor .45

Dividend 15.000 (.17 *&c.*
Diviſor 84

Dividend 1.00000 (.083 *&c.*
Diviſor 12

In the third Example, though there be neither *Unit* place in the Diviſor, nor (if there were) any Figure over it in the Dividend; yet by ſuppoſing the places continued to the left hand, you will ſee, that the firſt place in the Quotient is the place of *Tens.*

I have been the larger herein: That where the Rule cannot ſerve you with ſufficient exactneſs, by reaſon of the ſhortneſs of the Lines; you may help your ſelf by Arithmetick.

I will add this common Rule, *As the Divisor to the Dividend*; *So* 1 *to the Quotient.* Wherefore, if the Divisor be less than the Dividend; the Quotient is a whole or mixt Number: But if the Divisor be greater than the Dividend; then the Quotient is a Fraction, and in these cases a Decimal.

PROP. XVIII.

Gaging of an ordinary Vessel.

I Have before given you an account of the points: Wherefore, measure the Length of the Vessel, the Diameter at the Bung, and the Diameter at the Head, all in Inches and Tenths. Subtract the Diameter at the Head from that at the Bung: The difference multiply by 7, and divide by 10: The Quotient will be 7 tenths of the Difference to be added to the less Diameter for an equated Diameter.

On the Rule easily thus: On the double Scale set 10 to the Difference; against 7 shall be the said 7 tenths, to be added as before.

Then set the Gage-point (whether of Wine or Ale) to the Length; against the equated Diameter is the Content in Gallons.

Ex. Let the Length be 34 ½ In. the Diameter

at

at the Bung 29.4 In. the Diameter at the Head 25.3 In. This deducted out of that at the Bung, the difference is 4.1. Set 10 to 4.1; against 7 is 2.87, which added to 25.3 maketh 28.17; which you may call 28.2 it differing from the other but 3 cents of an Inch. And this is the equated Diameter; which having, set the Wine-point to 34.5; against 28.2 is 93 Gal. but setting the Ale-point to the said length; against 28.2 is onely 76.3 Gallons.

If setting the point to the length, the equated Diameter falleth beyond the Line; remove the point to the length of the Vessel in the other length of the Line of Numbers, which will bring the Diameter to the Content.

The Fractions are thus reduced into Pints (there being 8 Pints in a Gallon;) On the double Scale, set 10.0 to 8; against the Decimal is the Pints and parts of a Pint.

This being Mr. *Wingates* way of Gaging, I will give you it by the Logarithms from his *Tabulæ Logarithmicæ*, for the exactness thereof.

Having found the equated Diameter, *viz.* 28.17; to the Log. of the length and the Log. of the equated

1.53782	34.5
1.44979 }	—28.17
1.44979 }	
7.44484	Gen. Log.
r1.88224	76.25 Gal. Ale.

true Log. 7.44474

ted Diameter twice; add this general Log. 7.44484 for Ale. But for Wine, 7.53148: Then Cancel the first Figure of the Aggregate to the Left-hand: the remainer is the Log. of the Content in Gallons; which seek under the Index 3, and if the Content be under 100, you shall have it to hundred parts; if the Content be 100, or above, you shall have it onely to tenth parts; which yet seem sufficient in Gallon-measure. And so (*viz.* under the Index 3) I would have you seek the Log. of the Contents following. If you had used the general Log. for Wine; the Aggregate would be *x* 1.96888, Cancelling as before; the remainer is the Log. of 93.08 Gal. Then set 100 to 8; against 25 is 2 Pints, against .08 is 6 tenths of a Pint.

The fashioning of these Vessels being very uncertain, the space between the Bung and the Head being more Circular, and so more capacious in one than in another; Mr. *Brown* in his *Practical Gager* distinguisheth them into Spheroids, Conoides, *&c.* and objecteth against this way of Mr. *Wingates*, that 7 tenths of the difference is too much in some kind of Vessels, and too little in other, to be added to the less Diameter; Mr. *Wingate*, foreseeing this objection, in his Treatise above mentioned, an-

anſwereth to this purpoſe: 1. That this way is very plain and eaſie: 2. That in Gaging a Veſſel of 250 Gallons; you ſhall not miſs above a Gallon, over and under, of the exact truth: 3. That any way, that depends onely on the Length of the Veſſel, and of the Diameters at Head and Bung, is liable to the like uncertainty. I ſhall add: That ſeeing theſe Figures may be diſtinguiſhed by a skilful Gager, by the Eye (as Mr. *Brown* affirmeth;) by the ſame judgement he may allot what tenths he, by experience, ſhall think fit (they being between 5, and $7\frac{1}{2}$ for any Figure, as he ſaith,) to be added to the leſs Diameter. And when, on the Rule, you have ſet 10 to the difference; you have under your view and choice, what tenths to take, according to the judgement you have made of the Figure of the Cask.

An Appendix concerning the Logarithms.

PUrpoſing to ſhew you the reſolution of ſome Queſtions by thoſe excellent Numbers, the Logarithms; take theſe directions, for the better underſtanding the nature and uſe of them.

They are Artificial Numbers fitted to the Natural for the eaſe of Calculation. They are

Printed

Printed in Tables, having two Columns. One hath the Natural Number; againſt it is his Logarithm: ſo that the Log. of a whole Number is eaſily found. The Tables begin at 1, whoſe Log. is 0,00000. And reach commonly to 10,000 conſiſting every one of 8 Figures (though, except in great Numbers, we ſeldome uſe above 6, and if the remaining Figures exceed 50, we put a *Unit*, to the 6th.) ſo *Vlacq* and *Gellibrand:* Sir *Jonas Moore* alſo as far: To which are annexed Differences; by the help of which you are directed to find the Log. of any Number to 100,000: Mr. *Wingate*, in in his *Tabulæ Logarithmicæ*, hath them to 100,000; with Differences alſo; whereby making a proportion, (which is done ſpeedily by this Rule;) you have the Logarithms as far as 1,000,000.

The firſt Figure, called the Index (which is commonly prickt out, ſometimes left out,) ſhews how many Figures the anſwering Number, if whole, or the whole part thereof, if it hath a Decimal annexed, conſiſteth of, which are always more by one than the Index. So 0. is the Index of a ſingle Figure: 1. of two Figures: 2. of three Figures: 3. of four, *&c.*

Mark

Mark this Example: The Log. 3.54851 is the Log of 3536, a whole Number of four places, the Index being 3. But you ſee here, as the Index altereth, though the Numb. holds the ſame; yet the the whole part followeth the Index, being always a Figure more, and the reſt a Decimal.

3536	3.54851
353.6	2.54851
35.36	1.54851
3.536	0.54851
.3536	$\bar{1}$.54851
.03536	$\bar{2}$.54851
.003536	$\bar{3}$.54851

Alſo according to Mr. *Townly*'s way, cited by Sir *Jonas Moore* in his *Mathematical Compendium*; the Log. of a Decimal is the ſame, as if it were a whole Number, with this direction for the Index.

If the firſt Figure after the prick, be a ſignificant Figure, as in theſe .5,.25,.72,.123, *&c.* Let the Index be $\bar{1}$, if there be one Cypher, as in theſe .05, .082, *&c.* Let the Index be $\bar{2}$, if two Cyphers, then $\bar{3}$, and as the Cyphers increaſe, let the *Units* of the Index decreaſe; as you ſee alſo in the Example above.

According to the directions aforeſaid, the Log. of this whole Number 2872, is 3.45818. The Log. of this mixt Numb. 28.72, is 1.45818. Of this Decimal .2872, is $\bar{1}$.45818, of this .002872, is $\bar{3}$.45818.

To

To find the Number anſwering a Log. ſeek the Log. under as large an Index, as the exactneſs of the anſwer to the queſtion requires. If you would have the Fraction to hundred parts; ſeek it under an Index more by 2, than the Index of your Log. if it may be, which for Example let be 1.45818., you ſhall, under the Index 3, find it to be the Log. of 2872. But your Index tells you, that onely two places thereof are the whole Numbers; ſo the anſwering Number is 28.72, *&c.* 28 whole, and 72 centeſms. If the Log. be $\bar{2}$.45818; the Numb. anſwering is the ſame; but the Index tells you, it is a Decimal with one Cypher before it, *viz.* .02872.

Some uſes of the Logarithms.

WHereas, before the aforeſaid contrivance of the Indices by Mr. *Townly*, if one Number were perfect, and the other a Decimal: There was a different Rule in every operation for them: But by the ſaid contrivance, one is now ſufficient: I will give Examples onely of ſuch caſes, as have one Number a Decimal.

ſeek

With

With theſe two directions: 1. If in the Sum, Remainer, Half, *&c.* The Index be Ten or above; Neglect or Cancel the ſaid Figure in the place of *Tens:* 2. Where you are ordered to Subtract a greater Log. out of a leſs; add Ten to the Index of the leſs; and then Subtract.

1. *Multiplication.*

ADd the Logs of the two (or more) Numbers to be Multiplied; the Sum is the Log. of the Product. It may alſo be done, by Subtracting the Arithmetical Complement of the Log. of one of them, Index and all, out of the Log. of the other, as in the ſecond way of finding the ſuperficial Content of a Circle, following.

12.	1.07918
by. 25	9.39794
3.	10.47712

Which Arithmetical Comp. is the Remainer of every Fig. to 9, except in the laſt to the right hand, whoſe Remainer you muſt take to Ten, as in the Example.

Log.	9.89509
Ar.Co.	0 10491

2. *Division.*

SUbtract the Log. of the Divisor out of the Log. of the Dividend (whether of the two be greater or less;) The Remainer is the Log. of the Quotient.

12.	1.07918	
*by.*25	9.39794	
48.	1.68124	

It may also very conveniently be done, by adding the *Ar. Compl.* of the Log. of the Divisor, Index and all, to the Log. of the Dividend. As in the Examples of Gaging in this Book, the general Logs. being such.

3. *The Square-Root.*

HAlf the Log. of the Num. given is the full Log. of the Square-Root. If the Num. be a Decimal, add Ten to the Index, and then half it, as here:

.25	19.39794	
.5	9.69897	

4. *The Cube-Root.*

THe third part of the Log. of the Number given is the full Log. of the *Cube-root.* If the Number be a Decimal; add Twenty to the Index, and then Divide by 3, as here.

.25	29.39794	
.63	9.79931	

To

5. *To find a mean Proportional between two Numbers.*

ADd their Log' together, half the the Sum is the Log. of the mean Prop. when one is a Decimal, if the Sum of the Indices be Ten (as here) or above caſt away Ten, and then half it; if it be not Ten, add Ten to it, and then half it.

12.	1.07918
.25	9.39794
	x0.47712
1.732	.23856

6. *To find two, or more mean Proportionals between two Numbers.*

THis Propoſition, in Caſe of a Decimal, was ſomething perplext, the old way (as you may ſee in Mr. *Wingates*;) very clear and eaſy by this.

Subtract the Log. of the leſs number out of the Log. of the greater; the Difference or remainer divide by a number greater by one, than the number of means ſought: as here by 4, for 3 Means.

12.	1.07918
.25	9.39794
	1.68124
	.42031

This Quotient added to the Log. of the less number; the Sum is the first Mean: To which adding again the said Quotient; the Sum is the second Mean. And so forward, for as many Means, as the Quotient was at first ordered for.

			9.39794
Means			.42031
1		.658	9.81825
			.42031
2		1.732	x0.23856
			.42031
3		4.556	.65887

The sums are ye Logs. of ye means.

7. *Having the Diameter of a Circle; to find the superficial Content.*

TO the doubled Log. of the Diameter add the Log. of this Decimal .7854; the Sum is the Log of the Area or superficial Content. Or out of the doubled Log. of the Diameter, subtract the Ar. Comp. of the said Log. Index and all; the remainer is the same.

12.		1.07918
Double		2.15836
.7854		9.89509
113.1		x2.05345
		2.15836
		.10491
		2.05345

To

8. *To find the Log. of a Vulgar Fraction.*

Subtract the Log. of the Denominator out of the Log. of the Numerator; the remainer is the Log. of a Decimal Equivalent to the ſaid vulgar Fraction.	3	0.47712
	4	0.60206
	.75	9.87506

9. *To find the Log. of a Number with a Vulgar Fraction annext.*

		$12\frac{1}{4}$
Change the number into an improper Fraction, by Multiplying the whole number by the Denominator of the Fraction, and adding the Numerator to the Product; the Sum is the Numerator of the improper Fraction: Then ſubtract the Log. of the Denominator out of the Log. of the Numerator, as before; the remainer is the Log. of the ſaid number with a Decimal, equal to the ſaid vulgar Fraction annext.	49	1.69020
	4	0.60206
	12.25	1.08814

PROP. XIX.

To Gage a Stand.

HEre it is needful, firſt to ſhew you Multiplication and Diviſion on the Rule. Multiplication thus: On the double Scale ſet 1 to one of the numbers to be Multiplied; againſt the other, is the Product.

Diviſion thus: Set the Diviſor to the Dividend; againſt 1 is the Quotient. Or you may ſet the Diviſor to 1; againſt the Dividend is the Quotient.

The Stand is a Veſſel of a ſtrait Staff; one head whereof being greater than the other, it ſtands on the leſs: Hence the name, it may be accounted a Solid that tapereth ſtrait.

To find the Content of ſuch a Veſſel: By *Prop.* 12. find the Solid Content in Feet: which Multiply by 7.48 for Wine; by 6.13 for Ale.

Let the Diameters be, as in the Example of the ſaid 12*th. Prop.* Let the depth be 2.85 F. purſuing the Rule as in the ſaid *Prop.* you will find the Content in Feet 11.2 F. to which ſetting 1; againſt 7.48, is 84 Wine Gallons very near; againſt 6.13, is 68.75 Ale Gallons.

A

A ſhorter way by the Rule: Having the Aggregate of both Baſes, and the Mean or Square-Root, *viz.* 11.81; on the double Scale ſet the Decimal .401 (which may be cut) to the depth 2.85; againſt 11.81 is 84 Wine Gallons near. And if to the ſaid 2.85 you ſet the Decimal .4896, or .49; againſt 11.81 is 68.75 Ale Gallons: This without taking any notice of the Content in Feet.

By the Log: thus: by the 5th. *Section* of the Appendix aforegoing, find the Logs of the Baſes, with their anſwering numbers. Then by the 5th. *Sect.* of the ſame find a mean proportional between the two Baſes: by adding their Logs, and halving the Sum. Add together both Baſes, and this mean. To the Log. of the Aggregate, and the Log. of the depth, add this general Log.

2.47	.39270		
double	.78540		
	.10491		
	.68049	4.79	
2.	.30103		
	.60206		
	.10491		
	.49715	3.14	
	.68049		
Sum	1.17764		
Half	58882	3.88	Sq.R.
	1.07225	11.81	
2.85	.45484		
	.39681		Gen. Log.
	1.92390	83.93	W.G.

.39681

.39681 for Wine. But this .31017 for Ale: the Sum is the Log. of the Content in Wine or Ale Gallons: As here 83.93 Wine Gallons. But uſing the general Log. for Ale, the Sum of the Logs is 1.83726, the Log. 68.75 Ale Gallons: and theſe to an exact Content.

PROP. XX.

Gaging great Tuns.

I Have ſeen in a Treatiſe of Mr. *Henry Philips*, Tables Calcuſated to this purpoſe: whence taking out numbers anſwering the lengths, and breadths, or Diameters: and Multiplying them by the Inches of the depth; the Content is produced in Barrels: Which way, if the dimenſions be not whole numbers, is not without trouble; as you may ſee by his croſs Multiplications.

The way here ſhewn ſeems to me very genuine; and cannot be hard to him, that underſtands this Rule, and the Arithmetick taught in this Book here is alſo the eaſy and exact way by the Logs. wherein onely Addition, and Subtraction, and ſometimes halving or dividing by two, is uſed.

Mea-

Meaſure Lengths, Breadths, Diameters, and depths in Feet, by the Line of Foot meaſure on the Rule.

I. In a juſt Square Tun, Multiply the ſide by it ſelf; in a long Square Tun, Multiply the length by the breadth; this Product is the ſuperficial Content of the Bottom or Floor (call it the Baſe) in Feet: which Multiply by the depth of the Tun, or of the Liquor therein. This Product is the Content in Feet Solid; which divide by 5.875 (which would be cut as the Gage-points;) the Quotient is the Content in Barrels; and if you continue your Diviſion to two places of Decimals; the ſame ſhall be hundred parts; which bring into Gallons thus: On the double Scale ſet 100 to 36; againſt your Decimal are the Gallons anſwering.

One Example ſhall ſerve both theſe Caſes: a long Square Tun, whoſe length let be 6.2 F. the breadth 5.8 F. the depth 5 F.

1. The firſt Product is 39.96; the ſecond 179.8; the Quotient 30.6 Barrels.

2. On the Rule at 2 ſlips only; on the double Scale ſet 1 to 5.8; againſt 6.2 is near 36 F. for the ſecond, when two numbers are to be Mutiplyed; and their Product to be divided by a third; ſet the ſaid Diviſor, or three number to either of the numbers to be Multiplied;

againſt

againſt the other is the Quotient: Wherefore ſet 5.875 to 5; againſt 36 is 30.6 Barrels.

3. By the Log^s thus:

	.69897	5.
To the Log. of the depth	.76343	5.8
add in a Sq. Tun the Log.	.79239	6.2
of the ſide twice; in a	9.23099	Gen. Log.
long Sq. Tun, the Log^s	x1.48578	30.6 Bar.
of the length and breadth,		

and this general Log. 9.23099; Cancelling the the firſt Figure of the Sum to the Left-hand; the remainer is the Content in Barrels.

II. In a Cylindrical Tun, which is a round Tun, whoſe Diameters at top and bottom are equal:

1. By *Prop.* 14. find the Baſe in Feet; which Multiply by the depth; the Product is the Content in Feet; to be divided by 5.875, as before.

2. But by the Rule; having the Baſe, on the double Scale ſet 5.875 to the depth; againſt the Baſe in the Content in Barrels.

Ex. The Diameter is 8.45 F. the depth of the Liquor 3.8 F. ſet 1 on the Sq. line to 7.854; againſt 8.45 is 56.1 near: Then, on the double Scale ſet 5.875 to 3.8; againſt 56.1 is 36.27 Barrels.

3. By

3. By the Logarithms; find the Logarithm of the Baſe by *Sect.* 5. above, whoſe anſwering number you need not, in this Caſe look for; to this Log. and the Log. of the depth, add the Gen. Log. next before: Cancelling as before; the remainer is the Log. of the Content in Barrels.

1.74881	Log.	Baſe.
57987	3.8	
9.23099	Gen.	Log.
x 1.55958	36.27	Bar.

III. In a conical Tun, *viz.* a round Tun, whoſe Diameters at top and bottom are unequal, or if there be any ſuch Square ones; the Content in Feet is found wholly, as the Content of the ſtand.

1. By *Prop.* 19. from *Prop.* 12, *viz.* by finding, firſt the Baſes, and then a Mean proportional between them, to be added all three together; and Multiplyed into a third part of the depth; and then dividing by 5.875 as before.

2. But by the Rule: Having the Sum of both Baſes and the Mean; on the double Scale ſet 17.625 (which may be cut as the other points) to the depth; againſt the Sum is the Content in Barrels.

Ex.

Ex. Let the greater Diameter in such a Tun be 10 F. the less 8.8 F. the depth 4 F. the greater Base will be 78.54 F. the less 60.82 F. the mean proportional 69.12; the Aggregate of the two Bases and Mean 208.48. On the Scale set 17.625 to 4; against 208.48 is 47.31 Barrels

3. By the Logarithms; to the Log. of the Aggregate, and the Log. of the depth, add this general Log. 8.75387. Cancelling as before, the remainer is the Log of 47.31 Barrels.

2.31906	208.48	
.60206	4	
8.75387	Gen. Log.	
x 1.67499	47.31	Bar.

As for the Fractions in these Examples, set 10.0 to 36; against .6 in the first Example is 21 ½ Gal against .27 in the second is 9 ½ Gal. against .31 in the last is 11 Gal.

1. If you would have the Content of these Tuns in Ale-Gallons; for the Square and Cylindrical Tuns: Having the Solid Content in Feet; instead of dividing by 5.875; Multiply by 6.13, the Product is the Content in Gallons.

2. On the Rule, having by the first slip obtained the Area or Floor in Feet. Set this Decimal .1632 (which may be cut) to the depth; against the superficial Content or Base is the Content in Gallons.

Double Scale

3. By

3. By the Logarithms, inſtead of the General Logarithm 9.23099; uſe this General Logarithm .78729. The Aggregate of all the Logarithms is the Logarithm of the Content in Gallons: But for the third Example, the Content of them in Gallons is found altogether as the Content of the Stand, *Prop.* 19. from *Prop.* 12.

Theſe ways are, as I ſuppoſe, as ſhort and exact as any; the Reduction from Feet to Gallons or Barrels, on the Rule and by the Logarithms, being not the leaſt trouble: So that here is no need of Gallon-meaſure or Barrel meaſure, (being the Cube-Roots of the Inches in a Gallon, and the Feet in a Barrel;) nor any Tables; except thoſe of the Logarithms. Yet if the Gaging theſe Tapering Tuns ſeem too troubleſom to any, he may take the middle Diameter, or (that being too little) two or three Diameters at ſeveral diſtances; and working as in the Example of the Cylindrical Tun, and adding the Contents; he will come near the truth: and this is Mr. *Philips*'s advice: The like of the Square Tapering Tuns.

PROP. XXI.

The meaſure of a Shell or Flitch of Timber.

THe Content of the Section of a Cylinder, ſawn through from end to end; is found by Multiplying the length by the Baſe, which Baſe is the Segment of a Circle; the meaſure whereof is found, as after is ſhewn *Prop.* 1. *Part* 2. *Sect.* 6

The dimenſions hereof in theſe pieces are beſt taken in the middle, *viz.* the round part, the flat or ſawn part, and the Perpendicular or thickneſs; as alſo the length, all in Foot meaſure.

But for as much as the Content of the Segment cannot be found without knowing the Content of the Sector, whereof it is a part (as you will after ſee;) neither the Content of the Sector, without the Semidiameter, you ſhall find the Semidiameter thus: As the Perpendicular to the half flat; ſo the ſame half flat to a fourth number, which added to the Perpendicular maketh the Diameter: Hence the Semidiameter, then purſuing the Rule following in the ſaid 6th. *Sect.* of *Prop.* 1. *Part* 2. You will find the Content of the Segment to be Mul-

Multiplied into the length; which ſhall give you a true Content, to be reduced to the common Content, by the Rule at the latter end of *Prop.* 2. aforegoing.

But this being too troubleſom; or rather becauſe few pieces are ſplit or ſawn through, without being hewn little or much; you may uſe one of theſe two ways, at your diſcretion.

1. If a piece be conſiderably hewn, ſo that the Wanes are ſmall; meaſure it as unequal Sq. Timber, by taking the mean between the breadth and the depth, as in *Prop.* 5. onely abating ſomething in the one or other, as you ſee cauſe, and ſo bring it to a Square.

2. If it be but a little, or not at all hewn, to the whole round part add the thickneſs, and a third part thereof, all meaſured in Inches. A fourth part whereof account your Girt, and meaſure as round Timber.

To this purpoſe, on the double Scale ſet 3 to 4; againſt the thickneſs it ſelf, and a third part added to it.

Ex. The length is 30 F. the round part 50.6 In. the Perpendicular 14.4 In. ſet 3 to 4; againſt 14.4 is 19.2, which added to 50.6 is 69.8, one fourth whereof is $17\frac{1}{2}$ almoſt: For ſet 4 to 69.8; againſt 1 is 17.4.

Or prick down the said 19.2 on the flat part in the middle, and girt with your line of whole round part, and so far. Double the string twice, and measure it in Inches; and this is nearer to the common way. Then on the Square-line, set 12 to 30; against 17.4 is 63 ½ F.

Note, that this holds not so well in thin Sections, cut far from the middle of the Tree: In others it falls a little short of the common measure; as it is fit it should, there being far more loss in these than in round Timber. And as they fall short of the middle pieces in value; so a less exact measure may serve.

PROP. XXII.

To enlarge or diminish a Ship (or other Solid) keeping the mould.

THis *Prop.* I find in Mr. *Norwood*, but wrought with great trouble: Since the invention of the Logarithms by the Noble Lord *Nepair*, (whose name will never be forgotten) it is performed with great ease; either on the line of Numbers, or with more exactness by the Logs; or (it may be) on lines put on from them; at the rate, as the Square-line is on this Rule: For want of which, take this way by Compasses

on

on the line of Numbers; divide the ſpace between the burthen given, and the burden required, into three equal parts, with this extent: Set one Foot of the Compaſſes on each dimenſion, which makes the mould of the given Ship.

If the burden required be greater than the given; turn the other Foot to a greater number forward: If leſs turn it backward to a leſs number, which ſhall be the dimenſions required.

Ex. The burden given 100 Tun. Required 280.

	F.	*F.*
Length of the Keel . .	44	62.
Length of the Midſhip-beam	20	28.2
Depth of the hold . . .	9	12.7
Raking forward of the ſtem	13	18.3
Raking backward of the ſtern	7	9.86

By the Logarithms thus: Subtract the Logarithm of the leſs burden from the Logarithm of the greater. The difference divide by 3: The Quotient, or third part add to, or Subtract from the Logarithms of the ſeveral dimenſions of the given Ship; the Sums or Remainers ſhall be the Logarithms of the dimenſions required, with reſpect as above.

This holding in the dimensions of Masts, Yards, Cables, Anchors, *&c.* It must needs be of great use, being so easily come at: However it will free the Ship-wright from gross errour, and by it he may provide, and order his materials to the best advantage, according to the dimensions of the burthen required.

PART II.

The use of the double Scale of Numbers in some superficial measures, and Accounts.

1. OBserve these Rules, in the Rule of three direct: If the second number be greater than the first; the fourth shall be greater than the third, and on the contrary. But in the inverse Rule: If the second be greater than the first; the fourth is less than the third, and on the contrary.

2. If setting the first to the second; the third falls beyond the line; either remove the first to the second in the other length of the second line: Or take either the first number or the third number in the other length of the first line.

3. It is best, where the Question will bear it, to take the third, or fourth, or both among the subdivisions in the second length.

4. Observe well what number goeth with the Question: For in the direct Rule, that of the other two, which agreeth with it in name or respect, is the first, which you may set to either of the other, let the Question be:

5. If 32 Bricks pave one Square yard, how many Bricks will pave twelve yards? Here 12 being the third number, 1 is the first (both being yards) which set to 12 or 32; against the other is 384 Bricks.

6. It is not hard to know the degree of the fourth number: For the divisions increasing or decreasing in a Ten-fold proportion; the nature of the Question propounded, or the thing measured, will inform you. As in the Example above, the fourth number is either 384, or 38.4 or 3.84, but it cannot be the two latter, as is easie to see.

PROP.

PROP. I.

Multiplication.

Sect. 1. *The Square*

IS measured by Multiplying the side by it self: Let the side be 14 F. set 1 to 14; against 14 on the first line is 196 F. this is also found on the Square-line.

Sect. 2. *The Long-Square.*

Q. 1. MUltiply one side by the other: A Wall is $30\frac{1}{2}$ F. long, and 16 F. high. Set 1 to 16; against $30\frac{1}{2}$ is 488 F.

Q. 2. A length is 42 F. the breadth $0\frac{1}{4}$ F. or .75 F. Set 1 to the Decimal .75; against 42 is $31\frac{1}{2}$ F.

Q. 3. How many Men are in a body, where they stand 18 in Front and 8 deep? Set 1 to 8; against 18 is 144.

Sect. 3. *The Triangle.*

MUltiply the Base and Perpendicular, the one whole by half the other, which you will. In

In an end of an Houſe: The overway is 18 F. and from the pike to the overway (being the Perpendicular) 16. Set 1 to 8; againſt 18 is 144 F. Or ſet 2 to either Perpendicular or Baſe; againſt the other is the Content.

Sect. 4. *The Trapezium.*

IS an irregular four-ſided Figure: An irregular Plot (as of Land) before the Content can be found, is divided into theſe Trapezia, and Triangles.

1. To find the Content, draw a line from one corner to his oppoſite one, through the Trapezium: So as if it may be the two Perpendiculars falling from the other two Angles on this Diagonal line (as they call it) may fall within the Trapezium: Yet if one falls without, the Rule holds. So have you two Triangles having one common Baſe.

Multiply this Baſe by half the Sum of the Perpendicular; the Product is the Content of the Trapezium. Or ſet 2 to the Baſe; againſt the Sum of the Perpendiculars is the Content.

2. There is a Trapezium much uſed by the beſt Surveyurs of Land; who when they meaſure againſt a Crooked-hedge, carry their Chain ſtrait from mark to mark; and taking Per-

Perpendiculars from the Chain to the Nooks of the Hedge, describe Trapezia's, having each two Parallel sides, and two Right-Angles.

The Content they find thus: Multiply half the Sum of the Parallel sides (being the Perpendicular) by the nearest distance between them, being the intercepted part of the Chain; the Product is the Content.

So is measured any Trapezium, which hath two Parallel sides, though the Angles be not right: But then one side must be continued, if need be. For this line of nearest distance must be Perpendicular to the Parallel sides.

Thus may the *Rhombus* and *Rhomboides*, and infinite others, neither Equilateral nor Equangular, be measured.

Sect. 5. *Any Regular Figure*

(THat is, whose sides being equal, the Angles are also equal,) is measured by Multiplying half the Perimeter or Circuit by the Perpendicular, let fall from the Center to one of the sides.

What is the Content of a 6 sided Table? Each side 2 F. the Perpendicular 1.73 F. Set 1 to 1.73; against 6 is 10.4 F.

6 is 10.4 f.

Sect. 6. *The Circle, and his parts.*

THe ſuperficial Content hereof is beſt found by *Prop.* 14. *Part* 1. It is alſo found by Multiplying half the Circumference by the Semidiameter. For the Semicircle: Multiply half the Arch-line by the Semidiameter. The Sector, or any part contained between two Semidiameters and the Arch-line, is alſo ſo meaſured.

If a line be drawn through a Circle, not through the Center; it divides the Circle into two Segments.

The meaſure of the leſs is thus: Meaſure the Sector, whereof the Segment is a part. Then ſubtract the Content of the Triangular part; the remainer is the Content of the Segment. But in the greater, the Content of the included Triangle muſt be added.

Having the Diameter to find the Circumference. Having the Circumference to find the Diameter.

Set 7 to 22; againſt the Diameter is the Circumference: And ſet 22 to 7; againſt the Circumference is the Diameter.

Sect. 7. *To reduce the aforeſaid Figures to Squares.*

SOme of them, as the long Sq. Triangle, *&c.* are reduced, as is ſhewn in the meaſure of Timber of ſuch Baſes; the other, as alſo any irregular Figure, thus: Firſt find the ſuperficial Content; then ſetting the Square-line to his Squares, by *Prop.* 13. *Part* 1. againſt the ſuperficial Content on the line of numbers is the ſide of the Square.

PROP. II.

Diviſion.

Q. 1. IF 32 Bricks pave 1 Sq. yard; how many yards will 500 Bricks pave? Set 32 to 500; againſt 1 is 15.6 yards.

Q. 2. If 25 Trees coſt 21 *l.* what doth 1 Tree coſt? Set 25 to 21; againſt 1 is 0.84 *l.* wherefore the 8 is 16 *s.* and the 4, 9 *d.* $\frac{1}{2}$ as you will after ſee.

Q. 3. The Content of a long Square being divided by one ſide; the Quotient giveth the other. There are 144 Men placed 24 in Front; how many deep do they ſtand? Set 24 to 144; againſt 1 is 6.

Q. 4.

Q. 4. There are 280 Men to be ſet 18 in Front; how many will be in file? Set 18 to 280; againſt 1 is between 15 and 16: Set 1 to 18; againſt either of theſe is his reſpective number required, (for 15, 270; for 16, 288,) to make up the Rectangle.

PROP. III.

The Rule of Three direct.

WHere the length is taken in Feet, the breadth in Inches, and yet the Content required in Feet; 12 is the firſt Number. It is marked, as 12 on the Square-line, chiefly for the meaſure of

Sect. 1. *Plank or Board, and Glaſs.*

Q. 1. A Plank is 36½ F. long, and 18 In. broad: Set 12 to either length or breadth, here to 18 being neareſt; againſt 36½ is 54½ F.

Q. 2. A Board is 14 F. long, 26 In. broad; Set 12 to 14; againſt 26 is 30 F. and almoſt an half.

Q. 3. A Pane of Glass is 2.25 F. long, and 7.6 In. broad: Set 12 to 7.6; against 2.25 is 1.42 F. which .42 is almost an half.

Sect. 2. *Where the length and breadth are taken in Inches, and yet the Content required in Feet*; 144, *represented by* 14.4, *is the first number.*

A Pane of Glass is 31 ½ Inches long; 8 ½ In. broad: Set 144 to 8 ½; against 31 ½ is 1.86 F. suppose there be 7 such Panes: Set 1 to 1.86; against 7 is 13 F.

Sect. 3. *By the Yard.*

IN the following Questions, both length and breadth are given in Foot measure. Wherefore, if the Content be required in Yards; 9 is the first number, there being 9 Sq. Feet in a Square Yard. So they measure

Painting, Paveing, Wainscot, &c.

A length is 24 F. the breadth 10 ½ F. Set 9 to 10.5; against 24 is 28 yards.

Sect. 4.

Sect. 4. *By the Square of* 10 *Foot, as in Tiling, Flooring, &c.*

HEre 100 is the firſt number: A Roof is 41 F. long, and 22 F. broad: Set 100 (or 10, accounting it 100) to 22; againſt 41 is 9 Squares.

Sect. 5. *By the Square Rod, at* 16½ *Foot to the Rod, as in Brick-walls.*

HEre 272 25 (being the Square of 16.5) is the firſt number. A Wall is 110 F. long, and 9½ high: Set 272¼ to 110; againſt 9½ is 3.83 Rod.

He that hath much uſe of this, may have the point cut: Or he may cut it exactly thus: Set 10 on the ſecond to 16½ on the firſt; againſt 16½ on the ſecond cut this point in two places as the Gage-points, and fill as is above directed. The like may be put on at 324, for the Rod of 18 F. Sq. after the ſame manner.

Sect. 6. *By the Acre.*

IN Land-meaſure 160 Sq. Perches, at 16½ F. to the Perch, make an Acre. Therefore 160, repreſented by 16, is the firſt number: But for the parts of an Acre, 40 Perches make

a Rood or quarter: 80 Perches, 2 Rood or an half: 120 Perches, 3 Roods or 3 quarters. The lengths and breadths here are measured in Perches.

Q. 1. The length is 35 Perches, the breadth 19 Perches: Set 160 to 19; against 35 is 4.15 Acres; which 15 are 24 Perches, as you will see after.

Q. 2. A Triangular piece of Land hath the Base 24 Perches. The Perpendicular 16 $\frac{1}{2}$ Per. Set 160 to 16 $\frac{1}{2}$; against 12 (half the Base) is 1.24 Acres near. Or set 320 to 24; against 16 $\frac{1}{2}$ is 1.24 as before.

PROP. IV.

The inverse Rule.

HEre the number that goeth with the question is the first number, which may be set to either of the other.

Some say that 272 $\frac{1}{4}$ F. make a Rod of Brick-Wall, onely at 1 $\frac{1}{2}$ Brick thickness. If it be thicker, fewer Feet answer a Rod at an inverse proportion: If thiner, then more.

If it be so: And you would know how many Foot answer a Rod, (for Example) at two Bricks thickness: Say if 1 $\frac{1}{2}$ gives 272 $\frac{1}{4}$; What will 2 give? Set 2 to 1 $\frac{1}{2}$; against 272 $\frac{1}{4}$ is about

about 204, *viz.* 204. 18 F. and so at any othe thickness: which may be marked for first numbers, by changing the Rules, as before. That is setting 2 on the second to $1\frac{1}{2}$ on the first against $272\frac{1}{4}$ on the second mark on the first, *&c.*

PROP. V.

Fractions.

THe Fractions here are Decimals: A general Rule for them is; set 10 or 100 to the number of parts, which make up the Integer, or Whole in the Question; against every Decimal is his own share in the said parts.

Of two Shillings.

Q. 1. Let .64 be a Decimal of a Pound: It is evident that the 6 being in the place of tenth parts is 12 *s.* as for the 4, being so many tenths of two shillings, bring it into pence thus: Set 10 to 24 (the pence in two shillings;) against 4 is 9 *d.* $\frac{1}{2}$.

Of a Yard.

Q. 2. At 4 *s.* the Yard, What are 8 tenths? Set 10 to 48; against 8 is 38 *d.* $\frac{1}{4}$, *viz.* 3 *s.* 2 *d.* $\frac{1}{4}$.

Of a Square.

Q. 3. At 3 *s.* 6 *d.* the Square, What are 35 cents? Set 100 to 42; against 35 is 14 *d.* $\frac{1}{2}$.

Of a Rod.

Q. 4. At 14 *s.* the Rod, What come 58 cents to? Set 100 to 14; against 58 is 8 *s.* and little above 1 tenth of a shilling: Set again 10 to 12; against 1 $\frac{1}{4}$ is 1 *d.* $\frac{1}{2}$ near: In all 8 *s.* 1 $\frac{1}{2}$.

Of an Acre.

Q. 5. How many Perches are 15 cents of an Acre? Set 10.0 to 16.0; against 15 in the first Example is 24 Perches; against 24 in the second is 38 $\frac{1}{2}$ Perches almost.

Fractions not Decimals.

Q. 6. If you would know what a Fraction of any whole number is, in any parts of the said Whole. Set the Denominator, being the lower, to his Numerator; against the number of parts in the whole is the number of parts required. How many Farthings is $\frac{5}{7}$ of a shilling? Set 7 to 5; against 48 is 34, or 8 *d.* $\frac{1}{2}$.

Or

Or ſet the Denominator to the number of parts in the Whole; againſt every Numerator is his reſpective number.

Fractions into Decimals.

Q. 7. Set the Denominator to his Numerator; againſt 10.0 is the Decimal required. What Decimal of a Foot is $\frac{7}{12}$? Set 12 to 7; or againſt 10.0 is .58 near enough or .583.

The foregoing Queſtions well underſtood, it will not be difficult to apply the double Scales to any other Subject.

For a concluſion of this part I ſhall add: That, ſeeing if the lines were double in length to what they are, the anſwers to moſt Queſtions would be much clearer (every diviſion being as wide again, and ſo more ſubdiviſions;) If they could be made to 2 Foot length, yet for the Pocket; the ſatisfaction for the certainty above theſe, would compenſate the Charge. I have thought, that it might be done by two two-foot joynt Rules, to be made to ſlide back to back upon a Spline or Feather, as theſe do. I think there is no neceſſity of loops: So the lines of proportion might begin at the ſame end of the Rule. But I leave it to the contrivance of any ingenious perſon, that ſhall think it worth his conſideration.

PART III.

PART III.

1. *A Diagonal Scale, of* 100 *parts in a quarter of an Inch, eaſie to make and uſe.*

FInding ſuch a Scale in Mr. *Wings* Treatiſe of *Surveying-Land*, contriv'd by *J. W.* being about 3 Inches in breadth, and troubleſome to make, by reaſon of the many pricks in it (no fewer than 1760 in 20 Chains and the Diagonal) I here deſcribe one much narrower, and long as you pleaſe, without one prick, and but 4 ſhort lines more than his of the ſame length: Yet of as eaſie and certain uſe, as that or any other.

Let the breadth of the Rule be 1.85 In. or one Inch, 8 tenths and an half: The length as you pleaſe, divided into tranſverſe parallels, at the equal diſtance of a quarter of an Inch; which I call the Chain-lines.

Setting off 2 tenths of an Inch, on the Left-hand, for the Figures for numbering the Chains; Draw the firſt Long or Link-parallel repreſenting 0.

Draw

Draw 20 long parallels more at 8 cents of an In. equal diſtance from the firſt, and one another, (which I call the Link-lines;) with the proviſo following, *viz.* Let thoſe parallels, that repreſent 5, 10, 15, *viz.* the 6th. 11th. and 16th. from the Figures, be only ſcratcht through Chain-lines: Except in the Diagonal or uppermoſt Integer, where they may be drawn clean through.

On the top of the Scale, over the ſaid 5th. and 15th. ſtamp or cut a 5, over the tenth a Cypher: As alſo a Cypher between the ſcratches, the whole length of the Scale in the ſaid Link-line of 10. So will the Scale be divided, as it were, into two Scales, by the ſaid row of Cyphers: Figure the Chain-lines, as in other Scales, from the Diagonal Integer downward. Divide the uppermoſt Integer at each end into 5 equal parts: Draw Diagonals from 0, or the bottom on the Left-hand, to the firſt on the Right: From the firſt on the Left-hand to the ſecond on the Right; and ſo on as in other Diagonal Scales.

So, whereas you have in other Scales 10 one way, and 10 another; here you have 5 one way, and 20 another. And this is eaſily made, and of as eaſie uſe, and depends on as certain reaſon as any.

The

2. *The Uſe.*

THis Scale is fitted for any Decimal Chain, whereof *Gunters* for ſurveying of Lands is held the beſt. If therefore the places of Tens in the Links be 0, 2, 4, 6, or 8 (two of which Figures, *viz.* 2 and 6; or 4 and 8 may be ſet againſt their reſpective Diagonals:) Then uſe the firſt or the Left-hand Scale: But if the place of Tens in the Links be odd, *viz.* 1, 3, 5, 7, or 9; uſe the ſecond or Right-hand Scale: For that Diagonal which is 20 on the Left-hand Scale is 30 in the Right; that which is 40 in the Left is 50 in the Right, *&c.*

Ex. 1. Let 10.46 Chains, or 10 Chains and 46 Links be required to be taken off the Scale: Set one Foot of the Compaſſes on the Link-line repreſenting 6, in the tenth Chain-line, and firſt or Left-hand Scale, and extend the other to his due Diagonal of 40, in the ſaid Link-line of 6.

2. But to take off 10 Chains and 56 Links: Set one Foot on the Link-line of 6, in the ſaid tenth Chain-line, and the ſecond Scale; and extend the other to the ſame Diagonal; which is in this ſecond or Right-hand Scale 50: So have you 10 Chains and 56 Links.

3. So,

3. So, having a Line on your Plot; to know how many Chains and Links it is: Take it with your Compaſſes, and carry it Parallel; one Foot in one of the Chain-Lines, and the other through the Diagonal Integer; 'till it reſts on ſome Diagonal: And according as it falls in the firſt or ſecond Scale; ſo account the Tens of your Links: A little practice will make it very eaſie and certain.

This Scale alſo may be made to 12 Perches in the Inch (this being to 16) and put on the other ſide of the Rule: Such an one have I uſed a great while, it being a very convenient, and certain Scale.

3. *To reduce the Fraction Links of* Gunters *Chain into Poles.*

AN Acre is 160 Square Poles; 100,000 Square Links of this Chain. Therefore 625 Square Links make 1 Pole: If then the places of the Fraction be but 3; they cannot make two Poles.

If the places be 4, Multiply the firſt Figure; if 5, then Multiply the two firſt Figures, to the Left-hand, by 6: The Product ſet a place back toward the Right-hand; then add together the firſt or two firſt places of the Decimal and Pro-

Product so ordered: Adding also a *Unit* for every 6, that shall be in the Figures of the next place; the Sum is the number of Poles in the Fraction.

L.	8172
	48
P.	13
L.	21726
	126
P.	35

Here you see two Examples: One of 4 places, the other of 5: Also how the Products are placed and added. In the first there is once 6, in the second twice 6 in the Figures of the next places, which are added together with the rest.

The reason of this operation, Mr. *Wingate* (in whose Arithmetick I first met with it, after used by Mr. *Atwell*) deeming it not very obvious, leaves to the search of the curious: Take this hint from me towards it. If 100 (which are 100 Thousand Square-Links being an Acre) require 60 to be added to it, to make it 160 Poles (being also an Acre;) What shall any other number of Thousands of Square-links require, to turn it into Poles? Multiply and Divide, *&c.*

4. *A ready and exact way by the Rule.*

ON the double Scale set 10 to 16; against the Fraction is the number of Poles in it: Wherein the two last Figures may be neglected, onely if they exceed 50, add a *Unit* to the other. Set 80; and against 8.2, in the first Example is 13 Pole; against 21.7 in the second is 35 Pole near, *viz.* 34.7 P. If the Fraction be above 50,000: Take 5 out of the first Figure, for which set off 2 Roods; and find the Poles answering the Remainer. Let the Fraction be 87392. Taking 5 out of 8; the Remainer is 37392, to which answer near 60 Poles, in all 3 Rood, and 20 Pole near. For a conclusion, I shall add these Propositions following.

1. *Timber measure by the Logarithms.*

IN very large Timber, or for the trial of the truth of the divisions on the Rule. To the Logarithm of the length in Feet; and the Logarithms of the girt or side of the Square in Inches twice: Add this general Logarithm 7.84164. From the Sum cutting off the first Figure to the Left-hand; the Remainer is the

Logarithm of the Content; the common way in round Timber, but the true Content in Square.

1.74036	55	
1.69897	50	
1.69897	50	
7.84164	Gen. Log.	
x 2.97994	955	Foot

Ex. A length is 55 Foot: the girt or Sq. 50 In. Cancelling the first Figure, the Remainer is the Logarithm of 955 F. near which, at 40 Foot to the Load, is 23 Load, 35 Foot.

2. *To find the Content of a Tree growing, without disbarking it.*

BY a stiff Line or some other means get the length, also the Girt as is usual. Also with a Gimlet get the thickness of the bark (in Inches and Tenths) on each side the Tree, where you girt it. Both which thicknesses put into one Sum.

Then, a near proportion between the Girt and Diameter, being as $5\frac{1}{2}$ to 7: Set $5\frac{1}{2}$ to 7, against the Girt over the bark is his Diameter.

Subtract the Sum of the thicknesses out of the Diameter, the remainer is the Diameter under the bark.

Set 7 to $5\frac{1}{2}$; against this Diameter under the bark is the Girt sought. Yet the thickness of

of the bark is ſomething uncertain, but the difference cannot be much. And I ſuppoſe there is no nearer way without harm to the Tree.

3. *To find the Diameter of the head of a Veſſel within near.*

TAke the thickneſs of the head at the Taphole, (with a wire bent or any other way) in tenths of Inches. Then, as half the length of the Veſſel to the difference of Diameter of the Bung and Head without; ſo the thickneſs of the Head to the difference of Diameter without and within; which muſt be added to the Diameter without.

4. *Reduction of Wine meaſure to Ale-meaſure, and the Contrary.*

IT is done by the two Letters, *viz.* *W* and *A*, on the Square-line, take this Example: Set *A*, to 63 Gallons of a Wine Hogs-head; againſt *W* is about 51 $\frac{1}{2}$: And ſo many Ale-Gallons a Wine Hogs-head ſhould hold, and ſo of any other. But ſet *W* to the number of Ale-Gallons in a Veſſel; and againſt *A* is the number of Wine Gallons.

FINIS.

4 JU62